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CULTURE EFFECTS ON BUSINESS INTELLIGENCE SYSTEMS SUCCESS

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Dissertation

presented as partial requirement for obtaining the Master Degree Program in Information Management

NOVA Information Management School
Instituto Superior de Estatística e Gestão de Informação
Universidade Nova de Lisboa

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CULTURE EFFECTS ON BUSINESS INTELLIGENCE SYSTEMS SUCCESS

By

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Master Thesis presented as partial requirement for obtaining the Master's degree in Information Management, with a specialization in Knowledge Management and Business Intelligence

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ABSTRACT

Business Intelligence (BI) enables users to quickly access real time information to support their decision-making processes. Recently it has become one of the principal tools used by corporations to analyze business data and turn it into actionable insights. This study identifies the effects that culture has on the main and essential drivers for the success of a BI system in an organization. This research combines two culture dimensions (innovation culture and data-driven culture), with the Delone & Mclean information systems success model, in order to evaluate BI success in the post-adoption stage. Based on a sample of 201 users, the results reveal that the usage, user satisfaction, and data-driven culture are important precedents of net benefits. Both use and user satisfaction have a significant relationship between each other, and information quality, system quality, service quality, and innovation culture positively affect user satisfaction. Previous research has focused mainly on the adoption of BI information systems. However, this study evaluates the effects of cultural dimensions on a BI system's success in the post-adoption stage, while also identifying the critical success factors of this technology.

KEYWORDS

Business Intelligence, Data-Driven Culture, Innovation Culture, Information Systems, Business Intelligence success, DeLone & McLean

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LIST OF ABBREVIATIONS AND ACRONYMS

BI	Business Intelligence
D&M	DeLone and McLean
BA	Business Analytics
PLS-SEM	Partial Least Squares Structural Equation Modeling
OLAP	On-line analytic processing
IS	Information Systems
RDMS	Relational Database Management Systems
DDC	Data-Driven Culture

1. INTRODUCTION

In the new global economy, propelled by the development of technology, enterprises are growing exponentially, as does their information. In recent years the sheer volume of data managed daily by a corporation has increased at a rapid pace (Lees, 2021). Business Intelligence (BI) has become one of the central approaches by corporations to analyze business data and turn it into actionable insights (Suša Vugec et al., 2020). In fact, the worldwide BI and analytics market reached $24.05 billion in 2021, and it is expected to grow to $40.3 billion by 2028 (Spajic, 2022). This research project identifies the principal drivers of BI that are crucial to the success of this technology in an organization.

BI is an umbrella term that encompasses a wide variety of tools and software technologies that enable the user to access real time information in order to maximize their performance and decision making (Gaardboe et al., 2017). From an enterprise perspective, BI can be seen as the analytical and technology process in which raw data is turned into actionable insights, enabling new opportunities and competitive advantage (Wieder & Ossimitz, 2015). Additionally, by making it easier to aggregate, integrate, and manage structured and unstructured data (Ain et al., 2019), BI supports decision-making since many of these decisions can become “programmable” (Richards et al., 2019).

Previously, several studies were made on the principal determinants for a successful adoption of BI, e.g., Puklavec et al. (2018). The author ranked management support, expected benefits, organizational culture and perception of strategic value among the highest determinants, all of them belonging within the technological and organizational context (Puklavec et al., 2018). In addition, other researchers investigated the acceptance and continuous use of this technology. According to Yoon et al. (2014), users' motivation to learn a BI application is determined by the situational factors, including the necessary skills and resources and the organization's learning environment. (Yoon et al., 2014). However, few attempts have been made to identify the factors affecting the success of a BI system in a corporation. Even fewer attempts have been made to simultaneously evaluate the impact that culture can have. In order to fill this research gap, this study seeks to address the following research question:

- What are the key drivers in the success of a BI system in an organization?
- To what extent does culture influence the success of BI in an organization?

To properly answer these questions, we propose the theoretical support of the Delone and McLean (D&M) IS success model (the updated version of 2003). In order to comprehend the value and efficacy of IS decision making and IS investment, the D&M model aims to evaluate the effectiveness of information systems (IS). (DeLone & McLean, 2003). As a multidimensional model of IS, it uses the combination of five dimensions that are proposed to be interrelated rather than independent: system quality, information quality, use, user satisfaction, and net benefits (DeLone & McLean, 2003). In addition, we add two culture constructs: data-driven culture directly linked to net benefits and innovation culture connected to use and user satisfaction. Furthermore, in order to validate and collect data to better understand these variables, a questionnaire is employed focusing on the end-users of the BI system. The partial least squares structural equation modeling is used to analyze the results (PLS-SEM), since it gives precise estimates with small sample sizes.(Russo & Stol, 2021).

The contributions of this study are threefold. First, the research will aim to identify the principal determinants that are imperative for the success of a BI system in post-adoption phase. Secondly, and resorting from the dimensions used in the theoretical method added to the questionnaire results, it is possible to comprehend the personal experience and the user perception of these technologies. Lastly, this research will provide several insights on the impact that culture can have on the success of a BI system, identifying possible action points that can make an organization more data-driven and a more effective user of a BI system.

The next section presents the BI and IS culture concepts in depth, explains the D&M theory and formulates the study hypotheses. Thereafter, the description of methodology used and how the PLS-SEM model took part in analyzing the results are presented, as well as the respective analysis. The final sections analyze the study's findings, its limitations, and potential future research possibilities.

2. LITERATURE REVIEW

2.1. BUSINESS INTELLIGENCE

The first scientific definition of BI appeared in the 1980s, it was defined as a management philosophy that helps firms manage and enhance business information to increase decision making effectiveness (Gaardboe et al., 2017). BI is today considered an umbrella term that encompasses a wide variety of tools and software technologies that enable the user to access real time information in order to maximize their performance and decision making (Gaardboe et al., 2017). From an enterprise´s perspective, BI can be seen as the analytical and technology process in which raw data is turn into actionable insights, enabling new opportunities, position, and competitive advantage (Wieder & Ossimitz, 2015).

Chee addressed this multi-faceted definition of BI by proposing three different approaches: technological, managerial, and a product standpoint (Chee et al., 2009). The managerial approach mainly focuses on the process by which information is extracted from different sources to generate actionable insights, while the product perspective presents BI as a result from advanced processing of high-level data. Thus the technological standpoint, does not focus on the process, but rather on the tools, software, and solutions that allow decision makers to gather information from a wide variety of sources. A BI system is an enterprise architecture for an integrated collection and ensemble of all business within an organization, facilitating analysis, manipulation, and the access to and sharing of information. Thus, a BI system provides a single version of knowledge across an organization (Burtescu et al., 2013).

The classic and noncomplex architecture of a BI system can be divided into four major stages, each supported by its technological components. First are the data sources, in which information is typically inputted from different databases. Second, since the data usually comes unstructured, inconsistent, and unformatted, several data cleansing and transformations are carried out to uniformize the integration stage. This process is denominated as ETL (Extract, Transform, and Load) (Wu et al., 2007). It is critical for the success of a BI system that the data is loaded correctly and efficiently, since most of the information is loaded incrementally, that is, only the new and updated information is loaded. Third, a data warehouse centralizes the clean data from a wide variety of sources. This comprehensive repository is typically designed in a Relational Database Management Systems (RDMS) engine, using SQL programming language to manipulate and query the data (Wu et al., 2007). Finally, the analysis environment uses different end user tools and softwares to perform high-level analytics solutions on the data, such as:

- OLAP, a high-level multidimensional analysis technique with large amounts of data, for example filtering, aggregation, drill-down, and pivoting(Ain et al., 2019).
- Data mining and advanced analytics, by building predictive models, algorithms, and methodologies to rapidly identify patterns from large amounts of information (Hang & Fong, 2010).
- Dashboards and enterprise reports through BI visualization tools, enabling users to dynamically explore and access real time and historical data (Ain et al., 2019).

When referring to BI, it is common to join the term Business Analytics (BA). BA is an important part of BI that focuses on using analytical methods to extract value from data (Côrte-Real et al., 2014; Torres et al., 2018). Torres justified joining both terminologies, Business Intelligence and Analytics (BI&A), illustrating how important both components are (Torres et al., 2018). However, due to the similarity with the term OLAP processing and the analytical stage in general, we do not feel the need to distinguish between the two, "attempting to distinguish among the two terms may cause more confusion than it alleviates" (Torres et al., 2018). Therefore, when mentioning BI in this study, the term already includes all the analytical techniques that can be derived from BA.

Enterprises can benefit from BI in several manners. BI can be applied to a wide variety of industries, ranging from banking, transportation, health care, manufacturing, and retail (Chee et al., 2009). BI has the potential of analyzing vast amounts of data, enhancing existing applications (Torres et al., 2018) and operational processes such as sales, marketing, and inventory management (Richards et al., 2019). Moreover, BI provides business-centric practices and methodologies (Richards et al., 2019) that allow corporations to understand opportunities, strengths, and weaknesses, providing them with competitive advantage (Ain et al., 2019). In addition, by making it easier to aggregate, integrate, and manage structured and unstructured data, BI supports decision-making since many of these decisions can become "programmable" (Ain et al., 2019; Richards et al., 2019). However, obtaining BI success is expensive and complex, because it requires a solid infrastructure, software, licenses, training, and wages (Gaardboe et al., 2017).

Several studies have been made on the principal determinants for a successful adoption of Business Intelligence. Puklavec ranked management support, expected benefits, organizational culture, and perception of strategic value among the highest (Puklavec et al., 2018). Likewise, Yeoh and Koronios defined a conceptual framework for a successful implementation of BI Systems that divide the factors into three major dimensions: Organizational, process and technological dimension. (Yeoh & Koronios, 2010). In addition, other research has determined the acceptance and continuous use of this technology. Users' motivation to learn a BI application is determined by the situational factors, including the necessary skills and resources and the organization's learning environment (Yoon et al., 2014). However, few attempts have been made to identify the influencing factors affecting the success of a BI system in a corporation. In order to fill this research gap, this research project identifies the principal drivers of BI that contribute for the success of this technology in an organization in the post-adoption stage.

2.2. CULTURE IN INFORMATION SYSTEMS

Culture is an extensive and multi-dimensional term that in itself has an abundance of definitions. Kroeber & Kluckhohn identified 164 definitions of culture (Tam & Oliveira, 2017). Several studies have framed culture as ideologies, coherent sets of beliefs and values supported by fundamental presumptions, understandings, and the collective will (Leidner & Kayworth, 2006). Culture can be defined as a set of shared values, opinions, beliefs, and enduring meanings that characterize the behavior of a certain group (Tam & Oliveira, 2017). A company's culture is distinct and is shaped by the backgrounds and experiences of its employees. It influences almost every element of how individuals of a group interact with one another. (Weber & Pliskin, 1996).

In the IS literature, culture has been widely used in different backgrounds: acceptance of technologies in different cultures (Srite & Karahanna, 2006), different countries adopting mobile internet (Chung & Holdsworth, 2012), and the influence of use of m-banking in individual performance (Tam & Oliveira, 2019). Furthermore, Bradley (2006) studied IS success in both entrepreneurial and formal corporate cultures and Weber and Pliskin (1996) evaluated the effects of IS organizational culture in a merger and acquisition process , and many more. In fact, several studies consider that culture is an important factor in determining how social groups adapt to IS. (Leidner & Kayworth, 2006), as well as being a critical variable in its implementation success (Weber & Pliskin, 1996). Hofstede created one of the most solid theories used in the IS/IT area, (Tam & Oliveira, 2019) and over 60% of IS/IT studies analyzed used at least one of Hofstede's culture variables (Leidner & Kayworth, 2006). In this study we will be focusing on other culture constructs.

Hofstede's study dates back to the 1980s, while the BI is a fairly recent topic, evolving at a rapid pace, so we believe connecting it with more recent dimensions will bring a better and updated understanding of the relationship. Therefore, we propose the use of data-driven culture and innovation culture constructs. Data-driven culture is one of the crucial factors to take advantage of information in an organization. A culture of making business decisions based on insights extracted from data instead of pure human instincts is more likely to improve performance and can be used as a competitive advantage (Yu et al., 2021). Similarly, an innovative culture is a key tool of competition for many firms by building a climate in which employees are encouraged to take risks, while improving their innovation capacity. More importantly, an innovation culture also leads to product innovation and improvement. It should allow a BI system to make continuous advances, becoming more efficient and profitable (Martín-de Castro et al., 2013). We believe that using these dimensions will bring several contributions since there are very few studies that apply data-driven and innovation cultures, and even fewer that apply them when measuring IS success. In fact, to our knowledge there are no studies that combine these two culture variables to evaluate the BI system success in an organization.

2.3. DELONE & MCLEAN MODEL

DeLone and McLean's model was first constructed in 1992 as a conceptual framework to measure IS success and effectiveness (DeLone & McLean, 2003). At that time there was no clear measure to identify IS success, in fact, there were as many measures as studies (Urbach et al., 2010). Therefore, this model was constructed using information influence theory, which emphasizes the three levels of effect of information (receipt of information, influence on recipient, and influence on the system), and communication theory, which explains how information may be derived from a well-constructed and efficient system. All the measures were soon combined into six major categories: system quality, information quality, use, user satisfaction, individual impact, and organizational impact, creating a multidimensional model in which the relationships between the variables are interdependent (Dedić & Stanier, 2016; Mudzana & Maharaj, 2015). In 2003 DeLone and McLean updated the model into a new version (DeLone & McLean, 2003). This updated model expanded the use construct to include the purpose to use, integrated individual impact with organizational impact into a net benefit category, and introduced a new service quality variable. (Petter et al., 2013). The D&M IS success model assesses technical success via system quality, semantic success through information quality, and effectiveness success through use and user satisfaction. (DeLone & McLean, 2003). Information or system quality are the two most important quality factors to take into account when assessing the effectiveness of a single system. However, when gauging the system's overall performance, service quality may be the most crucial factor. Likewise, net benefit cannot be comprehended without considering system and information quality constructs (DeLone & McLean, 2003).

The model became prevalent for measuring IS success (Urbach et al., 2010) and has been widely used in various empirical works within different areas of study such as knowledge management systems (Halawi et al., 2007), employee portal systems (Urbach et al., 2010), e-commerce systems (Angelina et al., 2019), and decentralized technologies (Lashkari, 2021). More recently, a study published by Shim and Jo (2020) used the 2003 version of the D&M model to examine which key areas were beneficial to online health information sites. This study found that service quality was significantly correlated with user satisfaction and that information quality was significantly correlated with all outcome variables (Shim & Jo, 2020). Similarly, a recent study evaluated the success of an e-learning portal success as a solution to the COVID-19 outbreak (Shahzad et al., 2021) . The findings of the study reveal that system quality and information quality positively influence user satisfaction, and the same results were found between user satisfaction and E-learning portals. As exemplified, the D&M success model can be applied to a wide variety of contexts, regarding BI, several investigations have also been made using Delone & McLean IS success variables (Gaardboe et al., 2017; Torres & Sidorova, 2019; Wieder & Ossimitz, 2015; Yeoh & Koronios, 2010), yet few of them focus on post-adoption system success.

3. RESEARCH MODEL

This study will follow the research model illustrated in Figure 1. The model is based on the updated version of the D&M IS success model, using as independent variables: system quality, information quality, service quality to measure the overall quality of a BI system, as well as use and user satisfaction to analyze the user´s perception and contentment when repeating their use of the technology. According to DeLone and McLean (2003) the link between different success variables and the organizational advantages resulting from individual IS requires further study. Thus, we use net benefits as the dependent variable to evaluate the success of a BI system at an organizational level. Also, we add two culture dimensions: innovation culture, establishing the relationship with use and user satisfaction and data-driven culture directly connected to net benefits, in order to measure the effects that both can have on the success of the BI system in post-adoption stage.

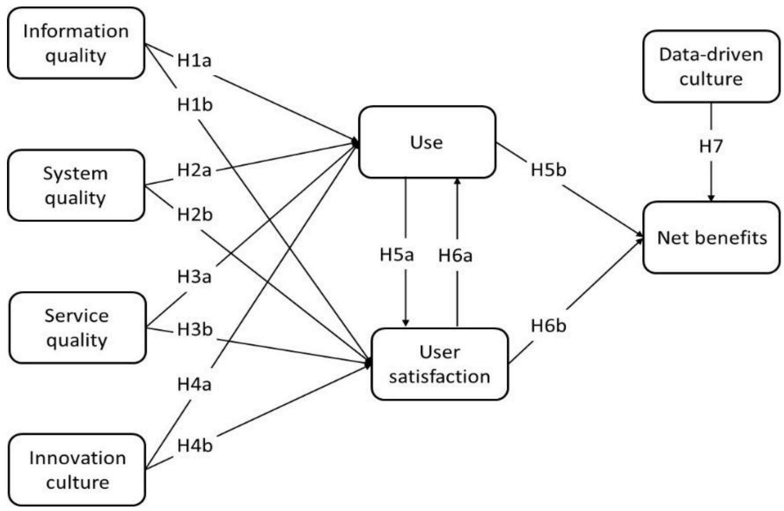

Figure 1 – Research Model

System quality

This dimension measures technical success and is defined as the desirable characteristics of an IS system (DeLone & McLean, 2003). It is produced during user-system interaction and is related to the surface and physical makeup of the system. It evaluates the user's attitude toward technology and the ease its of use to complete tasks (Urbach et al., 2010). The system should be flexible, scalable, and able to integrate data (Yeoh & Koronios, 2010). Hence, the desirable characteristics include convenience of access, ease of use, ease of learning, realization of user expectations, reliability, response time, and others (Halawi et al., 2007). Furthermore, system quality can be positively associated with use and user satisfaction, making it one of the pillars that determine user happiness and utilization (Ameen et al, 2019). A BI system that is poorly designed and unpleasant can still provide accurate and informative reports but obtaining them can be difficult. Users may be hindered from accessing their data and engaging with it, as well as navigating around the systems to discover the functionalities that are available (Trieu et al., 2022.). Thus, the following hypotheses are proposed:

H1a: System quality positively affects the use of a BI system.

H1b: System quality positively affects the user satisfaction of a BI system.

Information quality

Information quality is defined as the instructional properties formed by the information system in which its output represents accurate, up-to-date, and relevant data. According to Delone and Mclean (2003), information should be accurate, precise, current, timely, sufficient, and understandable. IS systems are intended to generate accurate and pertinent information, and the high quality of that information will help users make better business decisions and achieve successful results (DeLone & McLean, 2003). Information helps individuals reduce ambiguity by assisting in the identification of the options that are available and/or by predicting the outcomes of selecting an alternative (Wieder & Ossimitz, 2015). From a user's point of view, information quality is a product of user interactions with the system (Torres & Sidorova, 2019). When the information fulfils the user's expectations during the decision-making process, a favorable opinion on the quality of information will be formed (Lee et al., 2019). On the other hand, a BI system containing poor information quality will create incorrect decisions, since most of them will be based on missing, inconsistent, or improperly formatted data. In addition, most of the analytical components present in a BI system rely on accurate and well-structured information. For example, a machine learning model might not perform as well and a dashboard might produce errors in a BI system with poor information quality (Torres & Sidorova, 2019). Recent studies demonstrate the importance of information quality for a BI system, and it is considered one of the critical success factors in the success of a BI system (Adamala & Cidrin, 2011; Yeoh & Koronios, 2010) :

H2a: Information quality positively affects the use of a BI system.

H2b: Information quality positively affects the user satisfaction of a BI system.

Service quality

The service quality added to the updated D&M model refers to the level of support that the BI user receives (Mudzana & Maharaj, 2015). It comprises measures of the overall level of assistance provided by the service provider for a BI system, such as empathy of the personnel staff, responsiveness, technical competence, and reliability (Urbach et al., 2010). The concepts of IS service quality are reflected through user interactions and expectations regarding the BI system. A BI system with exceptional service quality requires highly knowledgeable experts satisfying users by being courteous, demonstrating excellence, and delivering error-free solutions in the time promised (Gorla et al., 2010). The level of service quality has a strong impact on how satisfied users are and how it affects consumers' feelings (Tam & Oliveira, 2017). Poor service can undermine users' confidence and reduce their satisfaction. Organizations may struggle to use BI capabilities in their activities due to a lack of fast, quality responses, limiting the system's use and eroding user's satisfaction (Ain et al., 2019). Therefore, two hypotheses were constructed:

H3a: Service quality positively affects the use of a BI system.

H3b: Service quality positively affects the user satisfaction of a BI system.

Innovation culture

The introduction of new or significantly better products and processes is known as innovation. (Kaasa & Vadi, 2010). It´s considered a critical factor for innovation, since it may foster employees' potential for invention, add to risk tolerance, and boost personal growth and development(Martín-de Castro et al., 2013). The innovation culture promotes the endorsement of innovation and organizational improvements as part of the organization's common beliefs (Hwang & Choi, 2017). As a result, the organization becomes more adaptive, and its competitors become more innovative and competitive. A culture that encourages innovation enhances participants' confidence, sense of equality, fairness, and belonging if they become involved early in the innovation process. Consequently, individuals become more inclined to accept changes in the organization (Hwang & Choi, 2017). The success and effectiveness of an organization has been attributed in large part to its culture. (Kaasa & Vadi, 2010). Information is a valuable resource that helps businesses in developing innovation and reducing managerial uncertainty (Duan et al., 2020). Leaders who prioritize innovation create better systems and procedures, are more future-oriented, more pro-active, more people-oriented, and quicker to respond accurately to the information they receive (Martín-de Castro et al., 2013). From a decision-making perspective, information is essential to the success of innovation and the elimination of uncertainty. (Duan et al., 2020). Similarly, higher levels of autonomy, more shared leadership, and more self-management are preferred by project managers and team members. They are more driven and skilled at carrying out more innovative tasks and embrace them as an opportunity and a positive challenge (Gemünden et al., 2018). Building organization values and behaviors that enable the employees to effectively and accurately use the information from a BI system to solve problems and support decision-making is critical for its success and satisfaction. Therefore, two hypotheses were developed:

H4a: Innovation culture positively affects the use of a BI system.

H4b: Innovation culture positively affects the user satisfaction of a BI system.

Use

System use focuses on measuring the degree and manner in which company's staff utilize the components of a system (Petter et al., 2013). The frequency, depth, duration, appropriateness, system dependency, actual use, and self-reported use of the system have all been taken into account when measuring system use. Thus, perceived use is a complete variable and does not include the intention of use (DeLone & McLean, 2003). Díez & McIntosh (2009) highlighted several factors that affected the use of information systems. According to their study end users who participate in IS development activities supported by top managers who are accustomed and experienced in managing large amounts of information, are most likely to take benefit from the system (Díez & McIntosh, 2009). In addition, the same study also highlights the value derived from using the system and the relevance of user satisfaction as a crucial factor to use. The following hypothesis was developed:

H5a: System use positively affects the user satisfaction of a BI system.

User satisfaction

Since system use may not be required in many situations, it may be useful to evaluate user satisfaction in order to assess the success of that IS. (DeLone & McLean, 2003). Satisfaction is an individual's feeling when comparing a product's or service's perceived performance to expectations (Oppong et al., 2021). From an IS perspective, it measures the feeling of satisfaction or dissatisfaction that a user receives from interacting with a BI system (Mudzana & Maharaj, 2015). In a series of positive and satisfied interactions with the system, an individual would be more willing to use it (Chen et al., 2020). User satisfaction is seen as one of the most crucial indicators of IS success (Urbach et al., 2010). The proposed dimension evaluates effectiveness, adequacy, efficiency, and overall satisfaction with the system (DeLone & McLean, 2003). Studies evaluating the success of online education platforms (Chen et al., 2020) and acceptance of nursing process information systems (Chen et al., 2020) found a positive relationship with user satisfaction, while a study measuring mobile healthcare service usage (Oppong et al., 2021) concluded that a relationship also between user satisfaction and continual usage. In that sense, the following hypothesis was formed:

H6a: User satisfaction positively affects the BI system use.

Net Benefits

In the new updated model (DeLone & McLean, 2003) the authors combined the previous dimensions: "Organizational Impact" and "Individual Impact" into a single variable, since using the term "impact" on the original variables can cause confusion because it could be either positive of negative (DeLone & McLean, 2003). Thus, "Net Benefits" is considered as "probably the most accurate descriptor of the final success variable" (DeLone & McLean, 2003). As used in the field of IS, net benefits is a multidimensional construct that measures how much IS aids target subjects in becoming successful (Kuo & Hsu, 2022). This dimension analyzes the degree to which a BI system contributes to the success of individuals and organizations (Lashkari, 2021). An effective BI system promotes efficient information sharing to support organizational structures and processes, leveraging the available resources to improve decision making, facilitate productivity, and increase cost-saving activities. A study from Hsiao-Hui Wang & Chen (2011) found a positive relationship between net benefits and both use and user satisfaction. In fact, the authors characterized user satisfaction as the most crucial indicator in their research framework. Therefore, two hypotheses were made:

H5b: Use positively affects the net benefits of a BI system in an organization.

H6b: User satisfaction positively affects the net benefits of a BI system in an organization.

Data-driven culture

An organization in which individuals share the viewpoint that having, comprehending, and using data will help them make better decisions can be referred to as having a data-driven culture. A data-driven culture is expected to move a company's culture toward business goals and serve as a powerful trigger to change the way products are developed. (Chatterjee et al., 2021). Such a culture can be defined as a fact-based and data-oriented environment (Abbasi et al. 2016) that helps organizations increase their performance by enabling better judgments and decisions that are based on data-insights (Vidgen et al. 2017). Several studies show a connection between the analytics field and the data-driven topic. Adrian et al. (2018), reviewed the implementation of Big Data Analytics within data-driven decision-making to create new business opportunities; Alwabel and Zeng (2021) used a data-driven methodology to build a machine learning algorithm to experimentally anticipate end consumers' adoption of consumer electronics; Jia et al. (2021) proposed a data-driven perspective to analyze the use of enterprise information system; Popovič et al. (2012)measured the effects of analytical decision making on the implementation of big data analytics; and Duan et al. (2020) used data-driven culture as one of the variables to measure the impact of business analytics on innovation. The culture of a company is comprised of an array of assumptions, values, symbols, and beliefs that determine the methods by which a firm runs its business. An organization should promote a data-driven culture among its constituents and urge stakeholders to be proactive in pitching management with fresh ideas. (Chatterjee et al., 2021). However, most companies that embrace BI and Analytics technologies do not see a return on their investment. According to a Harvard Business Review survey performed with 57 senior executives from large corporations, although all respondents said their companies are making an effort to move in that direction, only about one-third have been successful. The surveys consistently show this disparity, and that the degree of achievement has not significantly increased over time (Davenport & Bean, 2018). This dimension was therefore added when measuring BI system success in an organization to understand the critical points of action that an organization can address to become more data-driven, and consequently, succeed with all related BI tools and systems. Therefore:

H7: Data-driven culture positively affects the net benefits of a BI system in an organization.

4. METHODOLOGY

4.1. MEASUREMENTS

All measurements (Appendix A) were adapted from Urbach et al. (2010), Wu and Wang (2006), Nawaz Khan et al., (2019), Angelina et al. (2019), and Chatterjee et al. (2021), with slight modifications. System quality (SYSQ), information quality (INFQ), service quality (SERQ), and use (USE) were adopted from Urbach et al. (2010); innovation culture (INN) from Nawaz Khan et al., (2019); user satisfaction (SAT) from Wu and Wang (2006); net benefits (NETB) from Angelina et al., (2019), and Data-driven culture (DDC) from Chatterjee et al. (2021).

4.2. DATA COLLECTION

BI system's end users were surveyed in order to acquire data, in which a numerical scale from strongly disagree (1) to strongly agree (3) was used to score each item. The survey was initially created in English, and a pilot test with 30 respondents was conducted using a well-known survey website to ensure that any potential issues could be found and excluded in the main questionnaire. The pilot survey results did not indicate any problems, and therefore no changes were made.

After translating the questionnaire to Portuguese it was distributed between March and April of 2022 mainly via LinkedIn. A total of 684 messages were sent, and a follow-up reminder to those who had not responded after 15 days. In total, 201 complete responses were collected, with a 29% response rate.

Regarding the sample characteristics, as described in Table 1, of 201 respondents 123 (61%) are males, with the majority (73%) being between 25 and 34 years old. Concerning Education, 71 (35%) hold a Bachelor's Degree and 123 (61%) a Master´s Degree. As for occupation, 98% are employed, mainly in IT (56%), Business, consultancy, or management (19%), and Accountancy, banking, or finance (11%).

Table 1 - Sample characteristics

Distribution (n=201)					
Education			*Gender*		
High School or below	4	3%	Male	123	61%
Professional degree	3	1%	Female	78	39%
Bachelor	71	35%			
Master's degree or higher	123	61%	*Age*		
			<25	21	10%
Occupation			25-34	145	73%
Employee	197	98%	35-44	31	15%
Self-employed	2	1%	>44	4	2%
Other	2	1%			
Working Area					
Accountancy, banking, or finance	20	11%			
Energy and utilities	8	4%			
Engineering or manufacturing	7	3%			

IT	112	56%
Marketing, media, advertising	1	0%
Business, consultancy, or management	38	19%
Healthcare or pharmaceuticals	2	1%
Retail, transport, or logistics	8	4%
Other	5	2%

5. RESULTS

The structural and measurement models were examined using partial least squares (PLS). Meanwhile, the structural equation modelling (SEM) was used to perform the data analysis. To analyze the results we used PLS-SEM over CB-SEM, since the primary goal of this study is to identify key drivers on a non-normal distributed sample, using a complex model (more than six constructs). In this study we used Smart PLS v. 3.3.2 software to analyze the measurement model features and hypothesis testing (Hair et al., 2014).

5.1. MEASUREMENT MODEL

The measurement model was evaluated using three important metrics: internal consistency, convergent validity, and discriminant validity. Each of them are measured using a variety of tests. The findings of the measurement model are shown in Tables 2 and 3. Internal consistency is often assessed using Cronbach's Alpha (CA) and composite reliability (CR), whereby the threshold should be greater than 0.70. As seen in Table 3, all variables have values over 0.70. The average variance extracted (AVE) needs to be higher than 0.5 to support convergent validity. As seen in Table 3, each construct is greater than the indicated threshold (Hair et al., 2014). Finally, three factors should be considered while evaluating the discriminant validity. First, the correlation between any pair of constructs must be smaller than the square root of the AVE(Table 3). Second, the cross-loadings must be greater than the outer loadings values (Table 2). Thirdly, for all constructions, the HTMT ratio must be less than 0.9. Finally, the discriminant validity of the model is confirmed by Table 4.

Table 2 - PLS loadings and cross-loading

Constructs		InfQ	SysQ	SerQ	Inn	Use	Sat	DDC	NetB
Information Quality	INFQ1	**.788**	.457	.462	.482	.344	.516	.455	.413
	INFQ2	**.822**	.591	.503	.429	.315	.544	.417	.495
	INFQ3	**.788**	.487	.511	.445	.445	.518	.460	.430
	INFQ4	**.782**	.566	.493	.422	.244	.537	.396	.427
	INFQ5	**.783**	.589	.529	.465	.239	.555	.417	.435
	INFQ6	**.796**	.490	.530	.436	.340	.525	.447	.438
System Quality	SYSQ1	.477	**.828**	.418	.317	.331	.557	.294	.504
	SYSQ2	.556	**.840**	.526	.359	.303	.593	.285	.484
	SYSQ3	.628	**.841**	.526	.460	.331	.651	.412	.482
	SYSQ4	.529	**.839**	.385	.391	.377	.610	.334	.536
	SYSQ5	.605	**.865**	.561	.479	.398	.681	.431	.553
Service Quality	SERQ1	.563	.514	**.934**	.475	.336	.598	.466	.482
	SERQ2	.594	.531	**.946**	.477	.345	.579	.463	.448
	SERQ3	.579	.542	**.905**	.451	.288	.585	.456	.426
	SERQ4	.600	.528	**.883**	.390	.291	.587	.449	.434
Innovation Culture	INN1	.475	.407	.430	**.861**	.316	.476	.679	.303
	INN2	.482	.414	.420	**.884**	.259	.505	.712	.312
	INN3	.468	.412	.407	**.881**	.318	.504	.620	.268
	INN4	.486	.397	.403	**.764**	.347	.442	.666	.287
Use	USE1	.403	.371	.335	.307	**.865**	.504	.296	.514
	USE2	.355	.400	.319	.366	**.915**	.539	.304	.528

	USE3	.309	.313	.241	.282	**.847**	.416	.213	.439
User satisfaction	SAT1	.614	.633	.595	.506	.590	**.877**	.437	.694
	SAT2	.603	.684	.579	.520	.478	**.939**	.448	.660
	SAT3	.635	.697	.606	.551	.525	**.949**	.485	.707
	SAT4	.627	.710	.587	.524	.474	**.932**	.486	.675
Data-Driven Culture	DDC1	.442	.311	.388	.620	.202	.392	**.849**	.189
	DDC2	.519	.399	.493	.721	.283	.436	**.879**	.295
	DDC3	.468	.356	.448	.701	.297	.457	**.916**	.251
	DDC4	.485	.406	.418	.728	.307	.482	**.887**	.242
Net Benefits	NETB1	.485	.531	.426	.264	.549	.661	.200	**.901**
	NETB2	.516	.496	.418	.351	.475	.586	.276	**.871**
	NETB3	.493	.600	.464	.317	.494	.730	.287	**.912**

Table 3 - Means, standard deviations, correlations, and reliability and validity measures (CR, CA, and AVE) of latent variables

Constructs	Mean	SD	CA	CR	InfQ	SysQ	SerQ	Inn	Use	Sat	DDC	NetB
InfQ	5.589	.893	.882	.911	**.793**							
SysQ	5.240	.953	.898	.924	.666	**.843**						
SerQ	5.224	1.246	.937	.955	.636	.576	**.917**					
Inn	5.339	1.103	.869	.911	.563	.481	.489	**.849**				
Use	5.825	1.180	.849	.908	.408	.415	.344	.366	**.876**			
Sat	5.400	1.035	.943	.959	.671	.737	.640	.569	.560	**.925**		
DDC	5.752	1.111	.907	.934	.545	.421	.500	.789	.313	.502	**.883**	
NetB	5.755	1.102	.876	.923	.555	.608	.488	.344	.566	.740	.283	**.895**

Table 4 - Heterotrait-Monotrait Ratio of correlations (HTMT)

Constructs	InfQ	SysQ	SerQ	Inn	Use	Sat	DDC	NetB
InfQ								
SysQ	.747							
SerQ	.700	.626						
Inn	.644	.539	.542					
Use	.465	.470	.381	.423				
Sat	.736	.797	.681	.628	.620			
DDC	.604	.457	.536	.884	.347	.540		
NetB	.633	.682	.537	.398	.652	.809	.311	

5.2. Structural Model

The research model was also reviewed by examining the significance paths in the structured model. Figure 2 represents the structural model path coefficient with bootstrapping based on 5,000 iterations. To evaluate the model's multicollinearity, the variance inflation factor (VIF) was also tested. Since the VIF is lower than 5, there is no multicollinearity between the constructs. Thus, two different models were built since H5a and H6a established a reciprocal relationship between use and user satisfaction: model 1 using the use to user satisfaction relationship and model 2 using the user satisfaction to use relationship.

Figure 2 illustrates how the models account for 22.3% (model 1) and 32% (model 2) of the variation in BI use. In explaining use in model 1, the system quality (β = 0.213, ρ < 0.05) and innovation culture (β = 0.156, ρ < 0.05) are statistically significant; however, in model 2, they are not statistically significant, partially validating H2a and H4a. Additionally, neither the service quality nor the information quality are statistically significant in explaining BI use. However, H6a is supported by the statistical significance of user satisfaction explaining use (β = 0.528, ρ < 0.01).

The model explains 69.9% (model 1) and 65.3% (model 2) of the variation in user satisfaction of BI. All variables in both models are statistically significant in explaining user satisfaction. The system quality (β = 0.380, ρ < 0.01) in model 1 and (β = 0.430, ρ < 0.01) in model 2, information quality (β = 0.119, ρ < 0.10) in model 1 and (β = 0.153, ρ < 0.05) in model 2, service quality (β = 0.199, ρ < 0.01) in model 1 and (β = 0.211, ρ < 0.01) in model 2, and innovation culture (β = 0.136, ρ < 0.05) in model 1 and (β = 0.172, ρ < 0.01) in model 2, are statistically significant in explaining user satisfaction, supporting H1b, H2b, H3b, and H4b. In addition, use (β = 0.235, ρ < 0.01) is statistically significant in explaining the user satisfaction, confirming H5a.

The model explains 59.4% of the variation in net benefits in both models. The use (β = 0.227, ρ < 0.01) in model 1 and (β = 0.226, ρ < 0.01) in model 2, and user satisfaction (β = 0.678, ρ < 0.01) in both models) are statistically significant in explaining net benefits. Data-driven culture also is statistically significant in explaining net benefits (β = 0.128, ρ < 0.05, in both models). Thus, the hypotheses H5b, H6b, and H7 are supported.

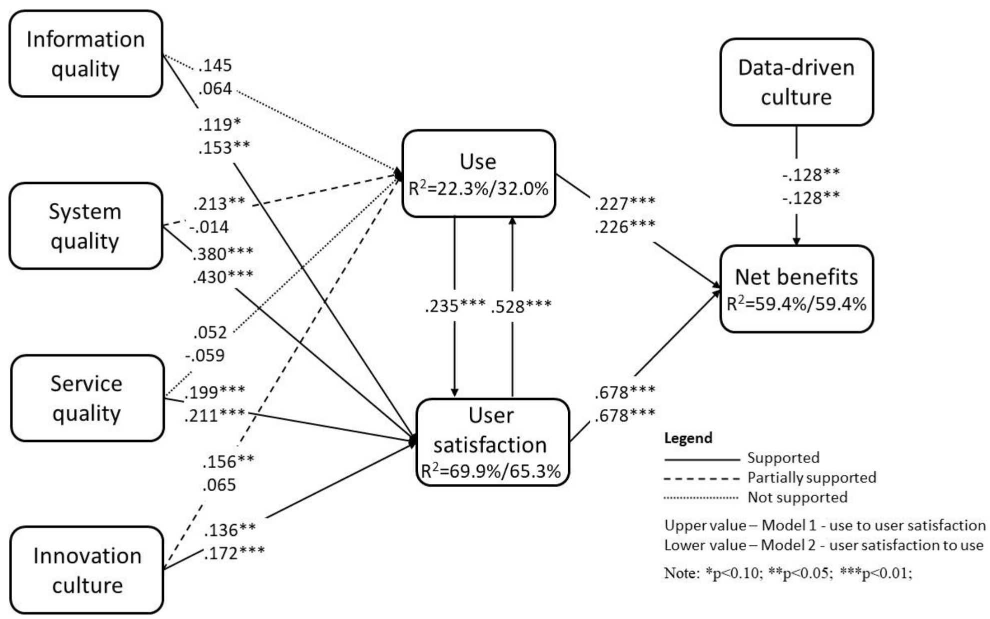

Figure 2 - Structural model results

6. DISCUSSION AND IMPLICATIONS

This study's major objective is to improve our understanding of how culture affects BI system success. To do so, an empirical analysis was undertaken focusing on cultural constructs and BI system success. Other studies were conducted to evaluate the influence of culture on the acceptance and implementation of IS systems. However, to the best of our knowledge this is the first empirical research that examines culture's direct effect on the success of a BI system. The greatest problem is defining precisely what culture is and how to quantify it, since there is a vast literature on the topic of culture and its applications in several contexts. Therefore, two main variables were chosen given their close relationship and possible influence with IS and the analytics environment in general: data-driven culture and innovation culture. To evaluate the success we used the D&M updated IS success model. The results demonstrate that, except for H1a and H3a, our hypotheses are totally or at least partially supported.

System quality and innovation culture only partially explain the use of a BI system. In model 1 (where usage explains user satisfaction), the model accounts for 22.3%, whereas in model 2, it accounts for 32% (in which the use satisfaction explains use). Thus, neither models achieve a strong predictive power. Regarding the hypotheses of the overall quality to explain the use of the BI system, only system quality (H2a) is partially supported, i.e. only supported in model 1, and neither information quality (H1a) nor service quality (H3a) are supported in both models. In addition, user satisfaction has a strong impact on BI system use, supporting H6a. These results are similar to those reported in other studies. When evaluating the effectiveness of healthcare information systems, Gaardboe et al. (2017) discovered that there is a positive correlation between system quality and usage but no association between information quality and use. Similarly, Baabdullah et al. (2019), by investigating the consumer use of mobile banking, identified system quality as a significant variable to explain use, but rejected the hypotheses that information quality positively affects the use of mobile banking.

The research model accounts for 69.9% of the variation in user satisfaction in model 1 and 65.3% in model 2. User satisfaction was shown to be positively impacted by the overall effectiveness of the BI system and its use, supporting H1b, H2b, H3b, and H5a. Tam and Oliveira (2017) obtained similar results, i.e., all three quality variables were positively associated with user satisfaction. Furthermore, Al-Okaily et al. (2021) discovered a substantial correlation between those three quality categories and satisfaction, as well as the fact that user satisfaction is influenced by use. Thus, this only enhances the importance of information, system, and service quality as critical drivers affecting user satisfaction. The overall quality of the system has a strong influence on user satisfaction towards a BI system.

The hypotheses H5b and H6b were also found to be supported. The research model explains 59.4% of the variance in net benefits of a BI system. Based on our findings, it is safe to say that the net benefits are influenced by use and user satisfaction. Similar results were concluded by other studies (Hsiao-Hui Wang & Chen, 2011; Kuo & Hsu, 2022), with user satisfaction being the most critical construct to explain the variance of net benefits.

Concerning the culture variables, innovation culture was found to have a similar behavior as the system's quality constructs. Innovation culture positively supports the variance of user satisfaction (H4b) and partially supports the variance of use (H4a). A possible reason to explain these results resides in the importance of innovation to improve product quality, in this case the organization's BI system. In fact, Martín-de Castro et al. (2013) found a relationship between the firm's innovation capabilities and product innovation. Finally, data-driven culture was found to have a significant impact on net benefits, thereby supporting H7. A study from Chatterjee et al. (2021) highlighted the importance of these constructs to improve the competitiveness of the firm in the market. Similarly, Adrian et al. (2018) confirmed that an analytics culture and data-driven decision-making are factors that influence the implementation success of big data technologies.

6.1. Theoretical implications

This research contributes to both the theory and practice of information systems in a number of ways. While most earlier BI studies focused mainly on implementation and adoption, this research focused on the post-adoption stage, by testing use, user satisfaction, and net benefits as constructs to identify the principal drivers and measuring the success of a BI system in an organization. The theorical model used for empirical testing was the well-known D&M IS success model, which was extended to a BI environment. In addition, IS culture was also incorporated in the model to understand the influence that innovation and data-driven culture can have on the BI system success.

This research demonstrates that maintaining an overall quality of the system aligned with an innovation culture is an important determinant for the satisfaction of using a BI system. It enhances the importance of understanding how the quality measures affect user satisfaction. Similarly, innovation culture and service quality are the two factors that partially affect the usage of the BI system. Based on the results, innovation culture proves to be an important factor on the system usage and users' satisfaction. Therefore, supporting the system quality with a share of values based on continuous growth and risk-taking while periodically monitoring and improving the overall quality can not only improve the efficiency, reliability, and accuracy of the system, but also its overall success within the firm.

Furthermore, both the usage and especially the user satisfaction were found to positively influence the net benefits. At the same time, another culture variable, the data-driven culture, has a direct and significant impact on net benefits. Therefore, creating a good set of practices and usage of the information for the BI system, such as providing easy access to support user's business decision-making, is revealed to be crucial for its success in an organization.

6.2. Managerial implications

From a practical standpoint, our research demonstrates that the overall quality of the system combined with a good innovation culture has a significant impact on user satisfaction, which consequently influences the usage and net benefits. In addition, data-driven culture was another cultural dimension included in this study since it could lead to further insights and improve the success of a BI system. Managers should create an environment in which employees must base their decision-making on available information while supporting risk-taking and creative initiatives. Reliable, accurate, and up-to-date information is key to support decisions. By continually updating and improving information that supports BI, users can enhance information quality. Being able to access trustworthy and relevant information is critical for providing stakeholders with the best insights. System developers should also focus on making a system that is well structured and easy-to-use, by which the user can easily find the information desired. A confusing and complex system can negatively impact the user’s satisfaction. Finally, managers should also focus on providing excellent service quality by having a competent team that responds quickly and accurately to the user’s request, while being courteous, helpful, and empathetic.

7. CONCLUSIONS AND FUTURE WORK

Obtaining the most benefit from the investment in building a BI system has become one of the main concerns in organizations. This research combines the D&M IS success model and two cultural dimensions to identify the principal drivers and the culture influences on the success of a BI system in an enterprise. System quality, information quality, service quality, innovation culture, and use all play important roles in user satisfaction. Based on our results, innovation culture and system quality partially influence the use, whereas user satisfaction has a significant impact on the usage of a BI system. This study empirically presents a positive relationship between use and user satisfaction and use and net benefits. Furthermore, it enhances the importance of building a culture in which decisions are based on factual information, since data-driven culture largely impacts the net benefits of a BI system.

When applying the results of this study in a broader context, several limitations should be taken into account. First, we concentrated on BI users from a country in Southern Europe. Future studies can look at different locations or other nations to improve generalization. Second, this study was focused on a BI system. There are other numerous tools and softwares within the data and analytics field of work, and different outcomes might be obtained when investigating different technologies or services. Third, we used our model to incorporate only two cultural elements, while using others may offer additional insights. Finally, we could have further investigated distinctive properties of a BI system by measuring various quality indicators.

BIBLIOGRAPHICAL REFERENCES

Adamala, Szymon & Cidrin, Linus. (2011). Key Success Factors in Business Intelligence. *Journal of Intelligence Studies in Business*, 1.

Adrian, C., Abdullah, R., Atan, R., & Jusoh, Y. Y. (2018). Expert Review on Big Data Analytics Implementation Model in Data-driven Decision-Making. *Proceedings - 2018 4th International Conference on Information Retrieval and Knowledge Management: Diving into Data Sciences, CAMP 2018*, 13–17. https://doi.org/10.1109/INFRKM.2018.8464770

Ain, N. U., Vaia, G., DeLone, W. H., & Waheed, M. (2019). Two decades of research on business intelligence system adoption, utilization and success – A systematic literature review. *Decision Support Systems*, *125*(April), 113113. https://doi.org/10.1016/j.dss.2019.113113

Al-Okaily, A., Al-Okaily, M., Ai Ping, T., Al-Mawali, H., & Zaidan, H. (2021). An empirical investigation of enterprise system user satisfaction antecedents in Jordanian commercial banks. *Cogent Business and Management*, *8*(1). https://doi.org/10.1080/23311975.2021.1918847

Alwabel, A. S. A. & Zeng, X. J. (2021). Data-driven modeling of technology acceptance: A machine learning perspective. *Expert Systems with Applications*, *185*(November 2019), 115584. https://doi.org/10.1016/j.eswa.2021.115584

Ameen, A., Alfalasi, K., Gazem, N. A., & Isaac, O. (2019). Impact of system quality, information quality, and service quality on actual usage of smart government. 2019 first international conference of intelligent computing and engineering (ICOICE),1-6. https://doi.org/10.1109/ICOICE48418.2019.9035144

Angelina, R. J., Hermawan, A., & Suroso, A. I. (2019). Analyzing E-Commerce Success using DeLone and McLean Model. *Journal of Information Systems Engineering and Business Intelligence*, *5*(2), 156. https://doi.org/10.20473/jisebi.5.2.156-162

Baabdullah, A. M., Alalwan, A. A., Rana, N. P., Kizgin, H., & Patil, P. (2019). Consumer use of mobile banking (M-Banking) in Saudi Arabia: Towards an integrated model. *International Journal of Information Management*, *44*(September 2018), 38–52. https://doi.org/10.1016/j.ijinfomgt.2018.09.002

Bradley, R. v., Pridmore, J. L., & Byrd, T. A. (2006). Information systems success in the context of different corporate cultural types: An empirical investigation. *Journal of Management Information Systems*, *23*(2), 267–294. https://doi.org/10.2753/MIS0742-1222230211

Burtescu, E., Cooper, J., Technology Ltd, H., Marian Dardala, U., Dusmanescu, D., Fotache, M., Garlasu, D., Romania Marius Guran, O., Ticiano Costa Jordão, L., Kahanwal, B., Konstantas, D., Nithchi, S., Paraschiv, C., Popescu, D., Gheorghe Sabau, I., & Wrembel, R. (2013). Database Systems Journal BOARD. In *Database Systems Journal: Vol. IV* (Issue 4).

Chatterjee, S., Chaudhuri, R., & Vrontis, D. (2021). Does data-driven culture impact innovation and performance of a firm? An empirical examination. *Annals of Operations Research*. https://doi.org/10.1007/s10479-020-03887-z

Chen, T., Cong, G., Peng, L., Yin, X., Rong, J., & Yang, J. (2020). Analysis of user satisfaction with online education platforms in China during the covid-19 pandemic. *Healthcare (Switzerland)*, *8*(3). https://doi.org/10.3390/healthcare8030200

Côrte-Real, N., Oliveira, T., & Ruivo, P. (2014). Understanding the hidden value of business intelligence and analytics (BI&A) Research-in-Progress. In *Twentieth Americas Conference on Information Systems*.

Chung, K. C., & Holdsworth, D. K. (2012). Culture and behavioural intent to adopt mobile commerce among the Y Generation: Comparative analyses between Kazakhstan, Morocco and Singapore. *Young Consumers*, *13*(3), 224–241. https://doi.org/10.1108/17473611211261629

Dedić, N. & Stanier, C. (2016). Measuring the success of changes to existing business intelligence solutions to improve business intelligence reporting. *Lecture Notes in Business Information Processing*, *268*, 225–236. https://doi.org/10.1007/978-3-319-49944-4_17

DeLone, W. H. & McLean, E. R. (2003). The DeLone and McLean model of information systems success: A ten-year update. *Journal of Management Information Systems*, *19*(4), 9–30. https://doi.org/10.1080/07421222.2003.11045748

Díez, E. & McIntosh, B. S. (2009). A review of the factors which influence the use and usefulness of information systems. *Environmental Modelling and Software*, *24*(5), 588–602. https://doi.org/10.1016/j.envsoft.2008.10.009

Duan, Y., Cao, G., & Edwards, J. S. (2020). Understanding the impact of business analytics on innovation. *European Journal of Operational Research*, *281*(3), 673–686. https://doi.org/10.1016/j.ejor.2018.06.021

Gaardboe, R., Nyvang, T., & Sandalgaard, N. (2017). Business Intelligence Success applied to Healthcare Information Systems. *Procedia Computer Science*, *121*, 483–490. https://doi.org/10.1016/j.procs.2017.11.065

Gemünden, H. G., Lehner, P., & Kock, A. (2018). The project-oriented organization and its contribution to innovation. *International Journal of Project Management*, *36*(1), 147–160. https://doi.org/10.1016/j.ijproman.2017.07.009

Gorla, N., Somers, T. M., & Wong, B. (2010). Organizational impact of system quality, information quality, and service quality. *Journal of Strategic Information Systems*, *19*(3), 207–228. https://doi.org/10.1016/j.jsis.2010.05.001

Hair, J.F., Hult, G.T.M., Ringle, C.M. and Sarstedt, M. (2014). A Primer on Partial Least Square Structural Equation Modeling (PLS-SEM), *SAGE*.

Halawi, L. A., McCarthy, R. V., & Aronson, J. E. (2007). An empirical investigation of knowledge management systems' success. *Journal of Computer Information Systems*, *48*(2), 121–135. https://doi.org/10.1080/08874417.2008.11646014

Hang, Y. & Fong, S. (2010). Real-time business intelligence system architecture with stream mining. *2010 5th International Conference on Digital Information Management, ICDIM 2010*, 29–34. https://doi.org/10.1109/ICDIM.2010.5664637

Hsiao-Hui Wang, E. & Chen, C.-Y. (2011). System quality, user satisfaction, and perceived net benefits of mobile broadband services. *8th International Telecommunications Society (ITS) Asia-Pacific Regional Conference*, *March 2009*, 1–10. http://www.econstor.eu/handle/10419/52334

Hwang, K. & Choi, M. (2017). Effects of innovation-supportive culture and organizational citizenship behavior on e-government information system security stemming from mimetic isomorphism. *Government Information Quarterly*, *34*(2), 183–198. https://doi.org/10.1016/j.giq.2017.02.001

Lees, H. (2021). Evolution of Business Intelligence: Past, Present, and Future. *TrustRadius*. https://www.trustradius.com/buyer-blog/evolution-of-business-intelligence

Jia, Y., Ge, S., & Wang, N. (2021). Analyzing enterprise information system's feature use: a data-driven perspective. *Information Technology and People*, *34*(1), 375–398. https://doi.org/10.1108/ITP-05-2019-0254

Kaasa, A. & Vadi, M. (2010). How does culture contribute to innovation? Evidence from European countries. *Economics of Innovation and New Technology*, *19*(7), 583–604. https://doi.org/10.1080/10438590902987222

Kuo, C. S. & Hsu, C. C. (2022). Continuance Intention to Use and Perceived Net Benefits as Perceived by Streaming Platform Users: An Application of the Updated IS Success Model. *Behavioral Sciences*, *12*(5). https://doi.org/10.3390/bs12050124

Lashkari, A. (2021). *Evaluating Blockchain Success: Integrating Organizational Decentralization with the DeLone and McLean IS Success Model*.

Lee, S. W., Sung, H. J., & Jeon, H. M. (2019). Determinants of continuous intention on food delivery apps: Extending UTAUT2 with information quality. *Sustainability (Switzerland)*, *11*(11). https://doi.org/10.3390/su11113141

Leidner, D.E. and Kayworth, T. (2006), "Review: a review of culture in information systems research: toward a theory of information technology culture conflict", MIS Quarterly, Vol. 30 No. 2, pp. 357-399.

Martín-de Castro, G., Delgado-Verde, M., Navas-López, J. E., & Cruz-González, J. (2013). The moderating role of innovation culture in the relationship between knowledge assets and product innovation. *Technological Forecasting and Social Change*, *80*(2), 351–363. https://doi.org/10.1016/j.techfore.2012.08.012

Davenport, T., & Bean, R. (2018). Big Companies Are Embracing Analytics, But Most Still Don't Have a Data-Driven Culture. *Harvard Business Review*. https://hbr.org/2018/02/big-companies-are-embracing-analytics-but-most-still-dont-have-a-data-driven-culture

Mudzana, T. & Maharaj, M. (2015). Measuring the success of business-intelligence systems in South Africa: An empirical investigation applying the DeLone and McLean Model. *SA Journal of Information Management*, *17*(1). https://doi.org/10.4102/sajim.v17i1.646

Nawaz Khan, S., Hussain, R. I., Ur-Rehman, S., Maqbool, M. Q., Engku Ali, E. I., & Numan, M. (2019). The mediating role of innovation between corporate governance and organizational performance:

Moderating role of innovative culture in Pakistan textile sector. *Cogent Business and Management*, *6*(1). https://doi.org/10.1080/23311975.2019.1631018

Srite, M., & Karahanna, E. (2006). The role of espoused national cultural values in technology acceptance. *MIS quarterly*, 679-704.

Oppong, E., Hinson, R. E., Adeola, O., Muritala, O., & Kosiba, J. P. (2021). The effect of mobile health service quality on user satisfaction and continual usage. *Total Quality Management and Business Excellence*, *32*(1–2), 177–198. https://doi.org/10.1080/14783363.2018.1541734

Petter, S., Delone, W., & McLean, E. R. (2013). Information systems success: The quest for the independent variables. *Journal of Management Information Systems*, *29*(4), 7–62. https://doi.org/10.2753/MIS0742-1222290401

Popovič, A., Hackney, R., Coelho, P. S., & Jaklič, J. (2012). Towards business intelligence systems success: Effects of maturity and culture on analytical decision making. *Decision Support Systems*, *54*(1), 729–739. https://doi.org/10.1016/j.dss.2012.08.017

Puklavec, B., Oliveira, T., & Popovič, A. (2018). Understanding the determinants of business intelligence system adoption stages: An empirical study of SMEs. *Industrial Management and Data Systems*, *118*(1), 236–261. https://doi.org/10.1108/IMDS-05-2017-0170

Richards, G., Yeoh, W., Chong, A. Y. L., & Popovič, A. (2019). Business Intelligence Effectiveness and Corporate Performance Management: An Empirical Analysis. *Journal of Computer Information Systems*, *59*(2), 188–196. https://doi.org/10.1080/08874417.2017.1334244

Russo, D. & Stol, K. J. (2021). PLS-SEM for software engineering research: An introduction and survey. In *ACM Computing Surveys* (Vol. 54, Issue 4). Association for Computing Machinery. https://doi.org/10.1145/3447580

Shahzad, A., Hassan, R., Aremu, A. Y., Hussain, A., & Lodhi, R. N. (2021). Effects of COVID-19 in E-learning on higher education institution students: the group comparison between male and female. *Quality and Quantity*, *55*(3), 805–826. https://doi.org/10.1007/s11135-020-01028-z

Shim, M. & Jo, H. S. (2020). What quality factors matter in enhancing the perceived benefits of online health information sites? Application of the updated DeLone and McLean Information Systems Success Model. *International Journal of Medical Informatics*, *137*, 104093. https://doi.org/10.1016/j.ijmedinf.2020.104093

Spajic, D. (2022). *B*usiness Intelligence Statistics: State of the Market in 2022. *DataProt*. https://dataprot.net/statistics/business-intelligence-statistics/

Tam, C. & Oliveira, T. (2017). Understanding mobile banking individual performance: The DeLone & McLean model and the moderating effects of individual culture. *Internet Research*, *27*(3), 538–562. https://doi.org/10.1108/IntR-05-2016-0117

Tam, C. & Oliveira, T. (2019). Does culture influence m-banking use and individual performance? *Information and Management*, *56*(3), 356–363. https://doi.org/10.1016/j.im.2018.07.009

Torres, R. & Sidorova, A. (2019). Reconceptualizing information quality as effective use in the context of business intelligence and analytics. *International Journal of Information Management*, *49*, 316–329. https://doi.org/10.1016/j.ijinfomgt.2019.05.028

Torres, R., Sidorova, A., & Jones, M. C. (2018). Enabling firm performance through business intelligence and analytics: A dynamic capabilities perspective. *Information and Management*, *55*(7), 822–839. https://doi.org/10.1016/j.im.2018.03.010

Trieu, V. H., Burton-Jones, A., Green, P., & Cockcroft, S. (2022). Applying and extending the theory of effective use in a business intelligence context. *MIS Quarterly*, 46 (1), 645-678. https://osf.io/tv6wh/?view_only=63b91a611b9a448f8df5ddb2fbfdcd79

T. Chee, L. Chan, M. Chuah and C. Tan. (2009). Business intelligence systems: state of-the-art review and contemporary applications. *Proceedings of the Symposium on Progress in Information & Communication Technology,* 2(4), 16-30. https://www.researchgate.net/publication/228741281

Urbach, N., Smolnik, S., & Riempp, G. (2010). An empirical investigation of employee portal success. *Journal of Strategic Information Systems*, *19*(3), 184–206. https://doi.org/10.1016/j.jsis.2010.06.002

Suša Vugec, D., Bosilj Vukšić, V., Pejić Bach, M., Jaklič, J., & Indihar Štemberger, M. (2020). Business intelligence and organizational performance: The role of alignment with business process management. *Business Process Management Journal*, *26*(6), 1709–1730. https://doi.org/10.1108/BPMJ-08-2019-0342

Weber, Y. & Pliskin, N. (1996). The effects of information systems integration and organizational culture on a firm's effectiveness. *Information & Management* (Vol. 30).

Wieder, B. & Ossimitz, M. L. (2015). The Impact of Business Intelligence on the Quality of Decision Making - A Mediation Model. *Procedia Computer Science*, *64*, 1163–1171. https://doi.org/10.1016/j.procs.2015.08.599

Wu, L., Barash, G., & Bartolini, C. (2007). A Service-oriented Architecture for Business Intelligence for assessing IT service management per-. *Ieee*, 1–7.

Wu, J.-H. and Wang, Y.-M. (2006). Measuring KMS success: a respecification of the DeLone and McLean's Model, *Information & Management*, Vol. 43 No. 6, pp. 728-739.

Yeoh, W. & Koronios, A. (2010). Critical Success Factors for Business Intelligence Systems. *Journal of Computer Information Systems*, *50*(3), 23–32. https://doi.org/10.1080/08874417.2010.11645404

Yoon, T. E., Ghosh, B., & Jeong, B. K. (2014). User acceptance of business intelligence (BI) application: Technology, individual difference, social influence, and situational constraints. Proceedings of the Annual Hawaii International Conference on System Sciences, 3758–3766. https://doi.org/10.1109/HICSS.2014.467

Yu, W., Wong, C. Y., Chavez, R., & Jacobs, M. A. (2021). Integrating big data analytics into supply chain finance: The roles of information processing and data-driven culture. *International Journal of Production Economics*, *236*. https://doi.org/10.1016/j.ijpe.2021.108135

APPENDIX A

Constructs	Items	Adapted from
System Quality	SYSQ1 – BI system is easy to navigate. SYSQ2 – BI system allows me to easily find the information I am looking for. SYSQ3 – BI system is well structured. SYSQ4 – BI system is easy to use. SYSQ5 – BI system offers appropriate functionality.	(Urbach et al., 2010)
Information Quality	INFQ1 – The information provided by a BI system is useful. INFQ2 – The information provided by a BI system is understandable. INFQ3 – The information provided by a BI system is interesting. INFQ4 – The information provided by a BI system is reliable. INFQ5 – The information provided by a BI system is complete. INFQ6 – The information provided by a BI system is up to date.	(Urbach et al., 2010)
Service Quality	SERQ1 – The responsible service personnel are always highly willing to help whenever I need support with the BI system. SERQ2 – The responsible service personnel provide personal attention when I experience problems with the BI system. SERQ3 – The responsible service personnel provide services related to the BI system at the promised time. SERQ4 – The responsible service personnel have sufficient knowledge to answer my questions regarding the BI system.	(Urbach et al., 2010)
Innovation Culture	INN1- My organization culture is challenging. INN2 - My organization culture is creative. INN3 - My organization culture is risk taking. INN4 - My organization culture is result oriented.	(Nawaz Khan et al., 2019)
Use	USE1 – I use a BI system. USE2 – I use a BI system to manage my data. USE3 – I use a BI system to make decisions.	(Urbach et al., 2010)
User Satisfaction	SAT1 – I am satisfied that BI meets my knowledge or information processing needs. SAT2 – I am satisfied with BI efficiency. SAT3 – I am satisfied with BI effectiveness. SAT4 – Overall, I am satisfied with BI.	(Wu & Wang, 2006)
Net Benefits	NET1- BI technology saves me time. NET2- BI technology is cost saving. NET3- Overall, BI technology is more beneficial to use.	(Angelina et al., 2019)
Data-Driven Culture	DDC1- My organization believes decisions should be based on available information coming from a BI technology. DDC2- My organization is open to new ideas and approaches that challenge current practices on the basis of new information. DDC3- My organization depends on data-based insights to support decision making. DDC4- My organization uses data-based insights for the creation of new services or products.	(Chatterjee et al., 2021)